A NOVEL USER SENSITIVE INFORMATION ADAPTIVE VIDEO TRANSCODING FRAMEWORK

BACKGROUND

Background

[0001]   Transcoding refers to the conversion of one digital file to another. The conversion includes, but is not limited to, format change, resolution change, and bit rate change. In video-on-demand applications, a host computer may respond to a user's request to view a stored video file. The host computer may transcode the stored video file to an appropriate video format and bit rate for transmission through a network to the user. The transcoded format may be compatible with the user's platform, e.g., a television or a personal computer. The host computer may also adjust the transmission bit rate to meet the bandwidth requirement of the network connecting the host and the user.

[0002]   Network connection between the host and the user may sometimes be unstable or congested. Video transmission on a wireless connection such as wireless fidelity (WiFi) network is especially susceptible to data loss and errors. Thus, the transcoder on the host usually reduces transmission bit rate to protect against such network conditions. However, a reduced bit rate typically degrades the quality of the video received by the user.

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BRIEF DESCRIPTION OF THE DRAWINGS

[0003]   Embodiments are illustrated by way of example and not by way of limitation in the figures of the accompanying drawings in which like references indicate similar elements. It should be noted that references to "an" or "one" embodiment in this disclosure are not necessarily to the same embodiment, and such references mean at least one.

[0004]   FIG. 1 is a block diagram of an embodiment of a video system.

[0005]   FIG. 2 is an example of a frame sequence including three frames.

[0006]   FIG. 3 is a block diagram of a static model of the video system.

[0007]   FIG. 4 is a block diagram of a dynamic model of the video system.

[0008]   FIG. 5 is a flowchart showing operations of a transcoder of the video system.

DETAILED DESCRIPTION

[0009]   FIG. 1 shows a block diagram of an embodiment of a video system 10. Video system 10 may be a personal computer, a file server, or any computing device having video transcoding capabilities. In one embodiment, video system 10 may be a video-on-demand (VOD) system that transmits a video stream to an end user through a network in response to the user's request. Video system 10 may be coupled to a memory 12 through a memory interface 17 and a memory path 18. Video system 10 may also be coupled to a network 15 through a network interface 19 for transmitting video streams to an end user. Network 15 may be a wire-lined, wireless network, or a combination of both. Network 15 may be a local area network, a wide area network, the Internet, or a combination of all of the above. Memory 12 may be a combination of one or more of volatile or non-volatile memory devices, or any machine-readable medium. For example, a machine-readable medium includes read-only memory (ROM); random-access memory (RAM); magnetic disk storage media; optical storage media; flash memory devices; biological electrical, mechanical systems; electrical, optical, acoustical or other form of propagated signals (e.g., carrier waves, infrared signals, or digital signals).

[0010]   Memory 12 may store a plurality of video files, including a media stream file 123, in one or more video formats. Media stream file 123 may include a sequence of frames. Part of each frame may contain information of particular interest or sensitive to a user. For example, FIG. 2 shows three consecutive frames, each of which includes a running person and two moving cars. The user may be more interested in the person than in the cars, and therefore may pay close attention to the details of the person. Thus, the user may designate the person as an object containing user sensitive information. The areas containing the person, as indicated by ellipses 21-23, are referred to as sensitive information parts (SIP) areas. The areas outside of the SIP areas are referred to as non-SIP areas.

[0011]   Referring to **FIG. 1**, in one embodiment, video system 10 may have a transcoding unit 16 comprising transcoder 110, a sensitive information parts (SIP) generator 120, and an optional SIP file analyzer 130, for applying a biased rate control to the video files. In one embodiment, transcoder 110 may assign more bits per macroblock (e.g., a 16-pixel by 16-pixel bock) to the SIP area than to the non-SIP area, thereby enhancing the quality of the SIP and the user experience. SIP generator 120 generates the SIP information for each frame. The SIP information may be generated concurrently with the transmission of the transcoded stream, or generated statically into a SIP configuration file 125 stored in memory 12. If the SIP information is generated offline and stored in SIP configuration file 125, the format of the SIP configuration file may not be readily compatible with transcoder 110. SIP file analyzer 130 may be used to convert the file format for transcoder 110 to resolve any format incompatibility.

[0012]   In **FIG. 1**, transcoder 110, SIP generator 120, and SIP file analyzer 130 are shown as hardware devices, which may be implemented by Application-Specific Integrated Circuit (ASIC), Field Programmable Gate Array (FPGA), or any hardware technology suitable for logic device implementation. These hardware devices may have direct access to the files in memory 12 through a direct memory access (DMA) controller 13. Alternatively, one or more of transcoder 110, SIP generator 120, and SIP file analyzer 130 may be implemented as software modules stored in a machine-readable medium, which is previously defined. These software modules may contain instructions executable by a processor 14.

[0013]   In a static embodiment, the SIP may be generated under the directions of a user. For example, a user may manually mark one or more SIP areas for each frame and assign each of the marked areas a priority. SIP generator 120 may generate the coordinates of each marked area and save them in SIP configuration file 125. Alternatively, a user may mark the SIP in the frame in which the SIP first appears. SIP generator 120 may use the

marked information to automatically locate the SIPs in the frames that follow. For example, referring to **FIG. 2**, a user may manually mark ellipses 21-23 to indicate that the running person contains the sensitive information. The user may alternatively mark ellipse 21 only. SIP generator 120 may analyze characteristics of the object (the running person) or the area contained in ellipse 21 and search for objects or areas having the same or similar characteristics in the succeeding frames. SIP generator 120 may utilize standard functions such as those described in the Moving Picture Experts Group-4 (MPEG-4) for the analysis and search. When SIP generator 120 locates an object or an area, the SIP generator may generate a mark, in the shape of an ellipse or any suitable shapes, to encircle it. The coordinates of the marks, whether generated by the user or SIP generator 120, may be stored in SIP configuration file 125. SIP configuration file 125 may store each SIP in the form of an item that includes a frame sequence number, a SIP number, a SIP priority, and the shape and coordinates of the mark encircling the SIP.

[0014]   The user may alternatively indicate to SIP generator 120 that an object (e.g., the running person) is the SIP without encircling the object. In this scenario, the user may describe characteristics of the object (e.g., an object of a certain color or a certain height-to-width ratio) to SIP generator 120. The user may alternatively specify an area of fixed coordinates and shape as the SIP area. SIP generator 120 may follow the user's directions to locate the objects or the areas in all of the frames.

[0015]   SIP generator 120 may also locate the SIP automatically without the directions from a user or with minimal input from a user. For example, a user may provide a priority for each of the frequently appearing objects. SIP generator 120 may compare the objects in a frame sequence and designate the objects that appear the most frequently and/or have the highest priorities as the SIP. Alternatively, SIP generator 120 may compare the objects in a sequence of frames and designate the objects that appear in the most central location of the frames as the SIP. In another scenario, SIP generator 120 may

compare the intersected areas in a frame sequence and designate the areas that appear the most frequently as the SIP.

[0016]   In some embodiments, video system 10 of **FIG. 1** may be implemented by a static model or a dynamic model. **FIG. 3** and **FIG. 4** illustrate embodiments of a static model and a dynamic model of video system 10, respectively. In both of the static and dynamic models, transcoder 110 may transcode media stream file 123 based on the SIP information and the available bandwidth of network 15. Transcoder 110 may determine a different bit rate for the SIP and non-SIP areas to ensure that the quality of SIP is not compromised by the limited bandwidth. The SIP area may be transmitted at a higher bit rate than the non-SIP area. If the available bandwidth is low or if network 15 is unstable, transcoder 110 may reduce the bit rate for transmitting the non-SIP area but maintain the bit rate for transmitting the SIP area. Transcoder 110 may alternatively reduce the bit rates for both the SIP and non-SIP areas but apply a higher bit reduction rate to the non-SIP area. To conserve more bandwidth for the high-priority SIPs, some of the low-priority SIP areas may be discarded. That is, the low-priority SIP areas may be encoded with the same bit rate as the non-SIP areas. Thus, video system 10 may adapt to various network conditions and utilize the bandwidth efficiently to deliver the sensitive information of high quality.

[0017]   In the static model of **FIG. 3**, SIP configuration file 125 is generated prior to the transmission of the transcoded video. SIP configuration file 125 may be imported from a different platform and may have a format not readily interpretable by transcoder 110. SIP file analyzer 130 may read SIP configuration file 125 and convert the file format to another format compatible with transcoder 110. Transcoder 110 may then generate a transcoded stream from media stream file 123 based on the SIP received from SIP file analyzer 130 and the bandwidth status of network 15.

[0018]   In the dynamic model of **FIG. 4**, SIP configuration file 125 and SIP file analyzer 130 may be dispensed with. SIP generator 120 generates the SIP information concurrently with the transcoding operations and directly sends the SIPs to transcoder 110. In one embodiment, transcoder 110 may feed the bandwidth status of network 15 to SIP generator 120, allowing the SIP generator to dynamically adjust the amount of SIP generated based on the network condition.

[0019]   **FIG. 5** is a flowchart illustrating an example of the operations of a transcoder in some embodiments, e.g., transcoder 110 of **FIG. 1**. At block 51, transcoder 110 receives a bandwidth status indicating the available bandwidth for transmitting the transcoded video. At block 52, according to the static model of **FIG. 3**, transcoder 110 receives SIP information from SIP file analyzer 130. Alternatively, according to the dynamic model of **FIG. 4**, transcoder 110 receives SIP information from SIP generator 120 and forwards the bandwidth status to the SIP generator. Although the SIP information as shown is received after the reception of the bandwidth status, the reception may be in any order and may be concurrent. At block 53, based on the bandwidth status, transcoder 110 determines the bit rates to transcode the SIP and the non-SIP areas. Transcoder 110 may also determine whether to discard the SIP having low priority. At block 54, transcoder 110 forms macroblocks approximating the marked areas or objects. At block 55, transcoder 110 transcodes each of the macroblocks in the SIP areas with a higher bit rate than in the non-SIP areas. At block 56, transcoder transmits the transcoded stream to an end user through network 15.

[0020]   In the foregoing specification, specific embodiments have been described. It will, however, be evident that various modifications and changes can be made thereto without departing from the broader spirit and scope of the appended claims. The specification and drawings are, accordingly, to be regarded in an illustrative rather than a restrictive sense.